

Executive Functions and Driving Performance in a High Traffic Urban Condition in Mild Cognitive Impairment: Results from a Large- Scale Driving Simulator Experiment

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BACKGROUND & AIM

Driving competence requires planning, critical thinking and generation of novel actions. The abilities that we often call upon to respond to such situations are described as “executive functions”. Mild Cognitive Impairment (MCI) refers to a transitional state between normal aging and dementia affecting ~15% of people >65 years old that develops into full-blown dementia with a high annual rate of conversion (~14% compared to the 1.5% of the general population, per annum). Few studies have explored driving competence in MCI, and, of those conducted, most have explored overall cognitive functioning, as it contributes to the driving behavior of people with MCI.

We were particularly interested in investigating executive functions in relation to driving behaviors, namely traffic flow and road safety, in a group of individuals with MCI.

MATERIALS & METHODS

The study is part of a large driving simulator experiment designed to assess the effect of cerebral diseases on driver performance. In our analyses, 34 MCI individuals (23 males) with a mean age of 68.59 (SD=9.19; range=53.0-87.0) years were included. All participants drove in a simulator after completing a comprehensive neuropsychological battery. The executive function construct was operationalized as the performance on the following neuropsychological tests:

- ❖ Trail Making Test part B
- ❖ Clock Drawing Test
- ❖ Phonemic fluency (Frontal Assessment Battery)
- ❖ Semantic fluency (Animals)

Z-scores were calculated and added to yield an overall executive function score.

Table 1. Urban and Rural driving sessions

Session	Area Type	Trial	Traffic	Distractor	~Length (Km)	Duration (Min)
1	Urban	1	Moderate	None	1.7	3:30
		2	High	None	1.7	3:30
		3	Moderate	Cell Phone	1.7	3:30
		4	High	Cell Phone	1.7	3:30
		5	Moderate	Conversation	1.7	3:30
		6	High	Conversation	1.7	3:30
		7	Moderate	None	1.7	3:30
2	Rural	8	High	None	1.7	3:30
		9	Moderate	Cell Phone	1.7	3:30
		10	High	Cell Phone	1.7	3:30
		11	Moderate	Conversation	1.7	3:30
		12	High	Conversation	1.7	3:30
Total					22.8	42:00

Driving variables reflect a high traffic urban conditions scenario.

Traffic flow was measured by:

- ❖ Average driving speed (km/h)
- ❖ Lateral position of vehicle from the right side road border (m)

Road safety was measured by:

- ❖ Reaction time (sec)
- ❖ Projected average time to collision with the vehicle ahead (sec)



Image 1. Foerst Driving Simulator FPF 1/4 cab.

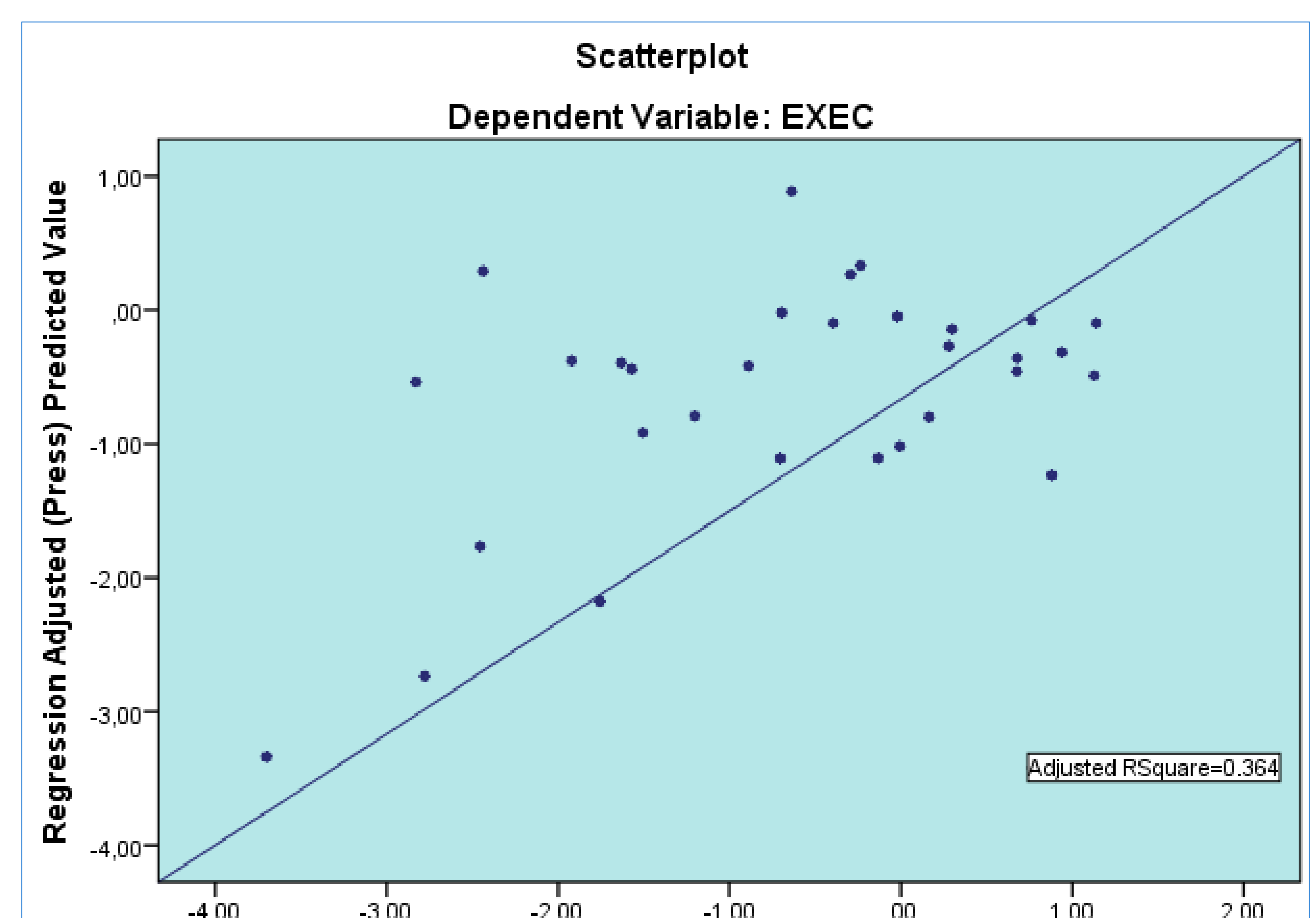
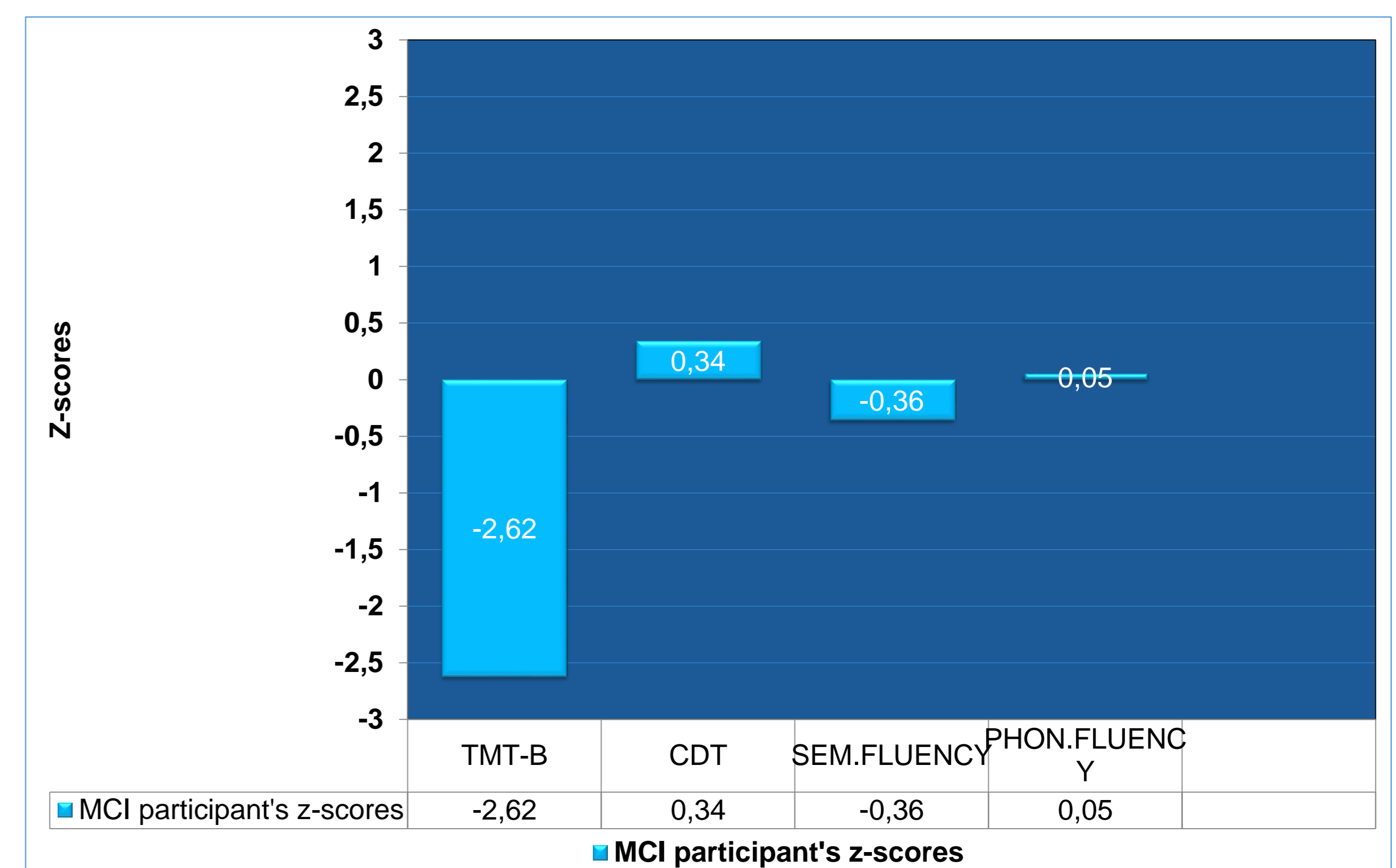


Image 2. Driving simulator high traffic urban conditions scenario.

Regression analyses were applied in order to investigate the contribution of executive functions on the variance of the four driving parameters.

RESULTS

MCI participants performed well below average on the Trail Making Test-Part B ($z=-2.62$), but in the average range on Clock Drawing ($z=0.34$), Semantic Fluency ($z=-0.36$) and Phonemic Fluency ($z=0.05$). Results from the regression analyses revealed that the overall model was significant ($p=.003$) for the four driving variables, with the executive function construct accounting for a large proportion of the variance (36%).



CONCLUSIONS

The ability to drive is a matter of paramount significance for public health as related to road safety and a cornerstone for the quality of life in Western societies. Our findings address the role of executive functions as an important part of the complex task of driving, highlight the ecological validity of paper and pencil neuropsychological testing to predict safe driving in individuals with MCI, and, thus, contribute to the open issue of optimal evaluation and management of driving risk in populations at risk. Larger samples and on road assessment studies are necessary to confirm the reliability of these findings.